EXPERTS FOR GROWTH

Einfluss verschiedener Calciumformen in der Blattdüngung auf die Calciumaufnahme und Fruchtqualität bei Obst

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Calcium als Blattdünger

Name of Company	Location	Product name	Ca Content% (w/w)	Chelation or Complexation	Soil Application	Foliar spray	Fertigation	Product Presentation
ADOB PYC	Poland	Calcium Nitrate sol & liquid	10.3 & 11				•	flakes & liquid
		Calcium Chloride	12.5			•	•	liquid
ADP	Portugal	Calcium Nitrate	19 min			•	•	prills
Agrolaser	Germany	Wuxal Ca	15			•		suspension
		Wuxal Aminocal	15	Aminoacids		•		liquid
Agrotecnic	Spain	Tecnokel Amino Ca	10%CaO	Aminoacids		•		liquid
Agrofill	Italy	Boromag Ca	10% CaO			•		suspension
		Zincal Mn Ca	10%CaO			•		liquid
Agronutrition	France	Capfol	14.1			•		liquid
		Megagreen	41			•		powder
Atlantica Agricola	Spain	Kalk Ca	5.8% CaO	EDTA	•		•	liquid
		Microcal Ca	8% CaO	amino & organic acids		•		liquid
Biobemca	Spain	AminoGustard Ca	5-10	Aminoacids	•	•	•	liquid
		Stimsol	5-10	Aminoacids	•	•	•	liquid
Biochim	Italy	Microcom 915 Mo	10% CaO			•	•	liquid
		Biflor Ca 82	8% CaO	Calcium glycerate		•	•	liquid
Biomet/Manvert	Spain	Manvert Calcium	14.4	lignosulphonate	•	•	•	liquid
		Manvert Sol.	9	polyhydroxilic acids	•	•	•	liquid
Biovill	USA	Folical	10	sugar alcohols		•	•	liquid
		Gold Label Ca	10	sodium gluconate		•	•	liquid
Chengdu NARTA	China	Calcium Nitrate	19				•	prills
Chin Specialty C	UK	Lionel Ca	10	EDTA	•	•	•	microgranular
Compo	Germany	Basfoliar Combi Stip	10.7			•		liquid
		Basfoliar Ca SL	12.3			•		liquid
Cosmocel	Mexico	Maxisay Calcium	20			•	suspension	
Fulcrum	Spain	Defender Calcio	14% CaO	amino acids		•		liquid
Greenhas Italia	Italy	Calbrovill	30 % CaO	carboxylic acids		•	•	powder
		Folacon 22	10% CaO			•	•	liquid
Haifa Chemicals	Israel	Multi-Cal GE	19 min			•	•	prills
		Multi-Cal FG	19 min		•			granular
Ibs/Hydro	Italy	Kamab 26	10% CaO			•		liquid
		Phytomed 26	7.6% CaO			•		liquid
ILSA	Italy	ILSAMIN Ca	8% CaO				•	liquid
		ILSAMIN CaMg	9% CaO				•	liquid
Indigrow	UK	Calcilig	16% CaO	lignosulphonate	•	•	•	liquid
		Gangrass	20% CaO		•			micro-prills
I.S.Agro	China	Chelated Ca	10	EDTA		•	•	powder
		Aminoacid Ca	10	amino-acids		•	•	powder
New China Chem	China	Calcium Nitrate	19		•	•	•	prills
Orsex	UK	Calflex	10% CaO			•		suspension
Orsmia	South Africa	Ormical	19				•	prills
		Nitrocal	13			•		liquid
Pfanlin	France	CalPlant	17.3% CaO			•	•	liquid
Produquimica	Brazil	Profol Ca B	10			•		liquid
Puccioni	Italy	Duo Calcio	15	lignosulfonate		•	•	liquid
Quimica Macac	Spain	Weligro Calcio	8.4% CaO		•	•		liquid
Reuver	Belgium	Reuvelop Ca	225 g/liter			•	•	suspension
SAS Greencore	Spain	Calcium plus 2000	12.3% CaO	org acids, gluconic ac, lignin			•	liquid
		Gelix Cal Boron	8% CaO	lignosulfonate		•		liquid
Sac. Chimica Lar	Italy	Folcanol Ca	15% CaO			•	•	liquid
Stoller Chemical	USA	Calcium 15	5	MEDTA	yes	•	•	liquid
		Aqua-Cal	10%/10V		•			liquid
Tradecorp	Spain	Benamin Ca	8			•	•	liquid
		Tradecorp Ca	10	EDTA		•	•	liquid
Valagro	Italy	Brexil Ca	20% CaO	lignosulfonate		•		microgranular
		Calbit C	10% CaO	lignosulfonate		•	•	liquid
Yara	Norway	Calcinit	19			•	•	prills
		Tropicote	19		•			prills
Yara Phosyn	UK	Bloxal	12.1			•		liquid
		Calfree	23.8			•		suspension

Note in table: the above list of companies and products is not exhaustive. Furthermore, a number of other companies offer products containing substantial amounts of calcium in combination with other nutrients.

Calcium als Blattdünger

FOLIAR NUTRITON USING INORGANIC SALTS: LAWS OF CUTICULAR PENETRATION

Abstract:
Laws of cuticular penetration have been elucidated using **calcium** and potassium salts.
Rates of penetration were greatly affected by humidity over cuticles, and hygroscopicity of salts. **Penetration requires dissolution of the salt. This is determined by the point of deliquescence (POD) of the salt and humidity over the salt residue**. POD is defined as that humidity over a saturated solution containing solid salt. When humidity is above POD the salt residue on the cuticle dissolves, while below a solid residue is formed and penetration ceases. **Hence, salts suitable for foliar nutrition should have a low POD. The following salts meet this criterion: $CaCl_2$ (33%), $MgCl_2$ (33%) K_2CO_3 (44%), $Ca(NO_3)_2$ (56%) and $Mg(NO_3)_2$ (56%). Salts having POD's above 90% (for instance K_2HPO_4, KH_2PO_4, KNO_3, Ca-acetate, Ca-lactate and Ca-propionate) are not suitable for foliar nutrition, as they penetrate only at a humidity close to 100%.** When humidity is above POD rate constants of penetration increased with increasing humidity by about a factor of three and maximum rates were measured at 90 to 100%. This is attributed to swelling of cuticles. The driving force for cuticular penetration is the concentration difference across the CM. Ion concentrations in the apoplast are in the millimolar range while water solubility of inorganic salts can be very high. Fortunately, with the exception of $MgCl_2$ all salts mentioned above having a low POD's also have high aqueous solubility ranging from 1.25 to 6.60 kg per kg water which shows that driving forces are very large following spray application and evaporation of excess water. Plasticiser and temperature did not affect rates of penetration and spraying should be done in the evening to take advantage of high humidity during the night.

Principles of foliar fertilization

Comparison of the efficiency of different Mg salts as foliar fertilizers and their point of deliquescence

Point of deliquescence: Necessary humidity for the formation of a saturated salt solution

Salt	Mg content of leaves after foliar fertilization [% Mg in DM]	Point of deliquescence [% rel. humidity] (25 °C)
$MgCl_2$	0.54	42
$Mg(NO_3)_2$	0.51	63
$MgSO_4$	0.10	96
Control	0.05	-

Data on Mg content of grape leaves after foliar fertilization of equivalent amounts of Mg from Hagler (1957) Proc. Am. Soc. Hort. Sci. 70, 178-182, and on the point of deliquescence of Mg salts from Aydogan (2003) Thesis, University Bonn

Calcium als Blattdünger

Table 2. Stability constants of metal chelates of EDTA, HEEDTA, and DTPA [1]

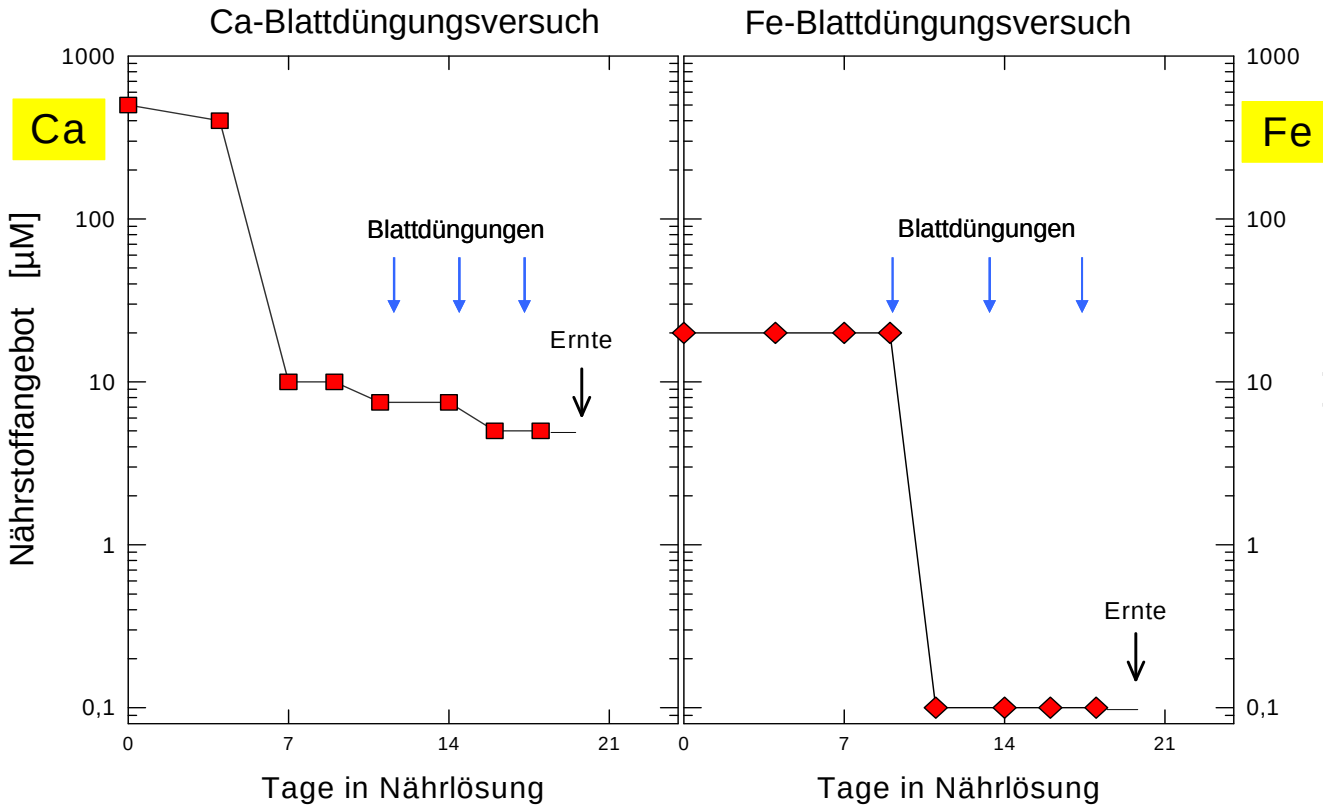
Metal ion	$\log K_{stab}$		
	EDTA	HEEDTA	DTPA
Al^{3+}	16.3	14.3	18.6
Ba^{2+}	7.86	6.3	8.87
Ca^{2+}	10.69	8.3	10.83
Co^{2+}	16.31	14.6	19.27
Cu^{2+}	18.80	17.6	21.55
Fe^{2+}	14.32	12.3	16.5
Fe^{3+}	25.1	19.8	28.0
Mg^{2+}	8.79	7.0	9.30
Mn^{2+}	13.87	10.9	15.60
Ni^{2+}	18.62	17.3	20.32
Pb^{2+}	18.04	15.7	18.80
Sr^{2+}	8.73	6.9	9.77
Zn^{2+}	16.50	14.7	18.40

Calcium als Blattdünger

Produkte zur Verbesserung der Ca-Versorgung
Biologische Wirkungsvergleiche von Ca-Verbindungen

Prüfungen in Nährlösungsversuchen mit gezieltem Nährstoffmangel

Typisches Schema des Nährstoffangebots in der Nährlösung bei Ca- oder Fe-Blattdüngungsversuchen



Calcium als Blattdünger

Ca-Mangel-Symptome
jüngerer Blätter
der Buschbohne
bei Angebot von
7,5 µM Ca in der
Nährlösung

Calcium als Blattdünger

Vergleich anorganischer Ca-Salze mit organischen Ca-Verbindungen als Blattdüngung

$Ca(NO_3)_2$ *versus* a) Ca-Ascorbat
b) CaEDTA

Calcium als Blattdünger

Vergleich anorganischer Ca-Salze mit organischen Ca-Verbindungen als Blattdüngung

Blattspritzungen mit 0,5 % Ca (= 125 mM Ca) zweimal/Woche

Kontrolle
500 µM Ca

VE-Wasser

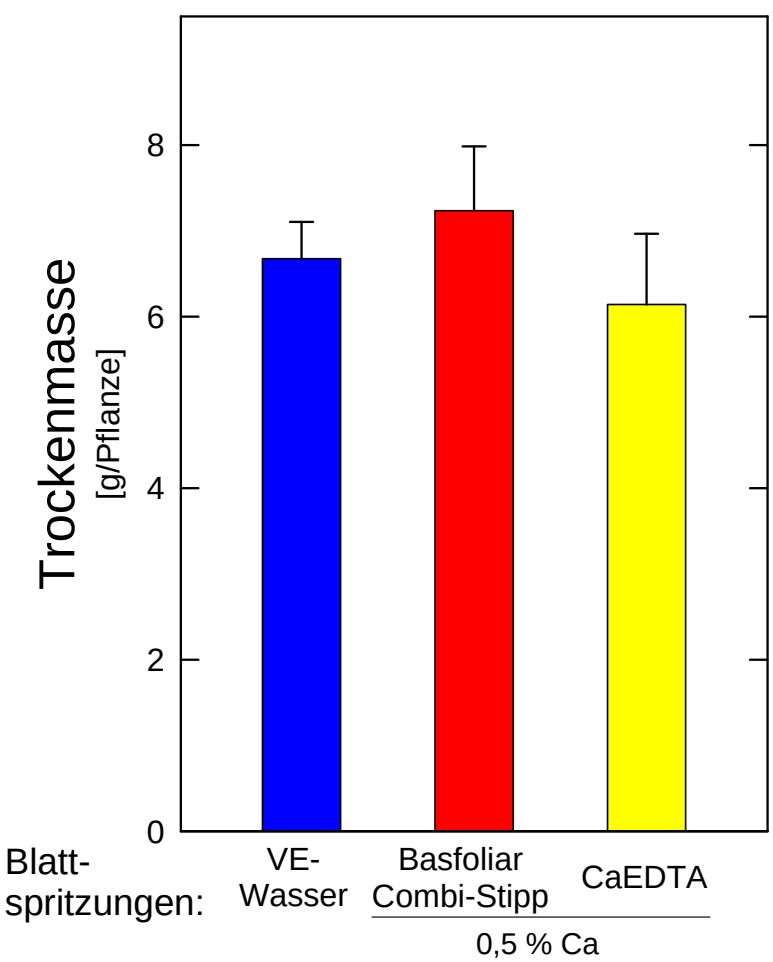
$Ca(NO_3)_2$

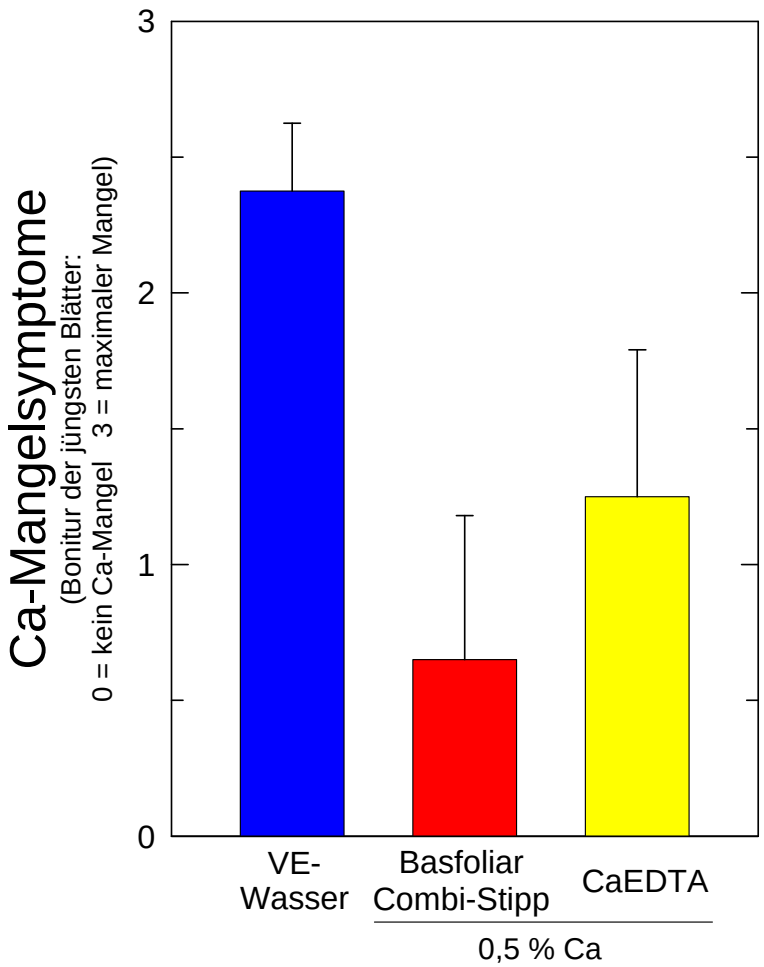
Ca-Ascorbat

Ca-Angebot der Nährlösung 7,5 µM die letzten 13 Tage

Calcium als Blattdünger

Vergleich anorganischer Ca-Salze mit organischen Ca-Verbindungen als Blattdüngung

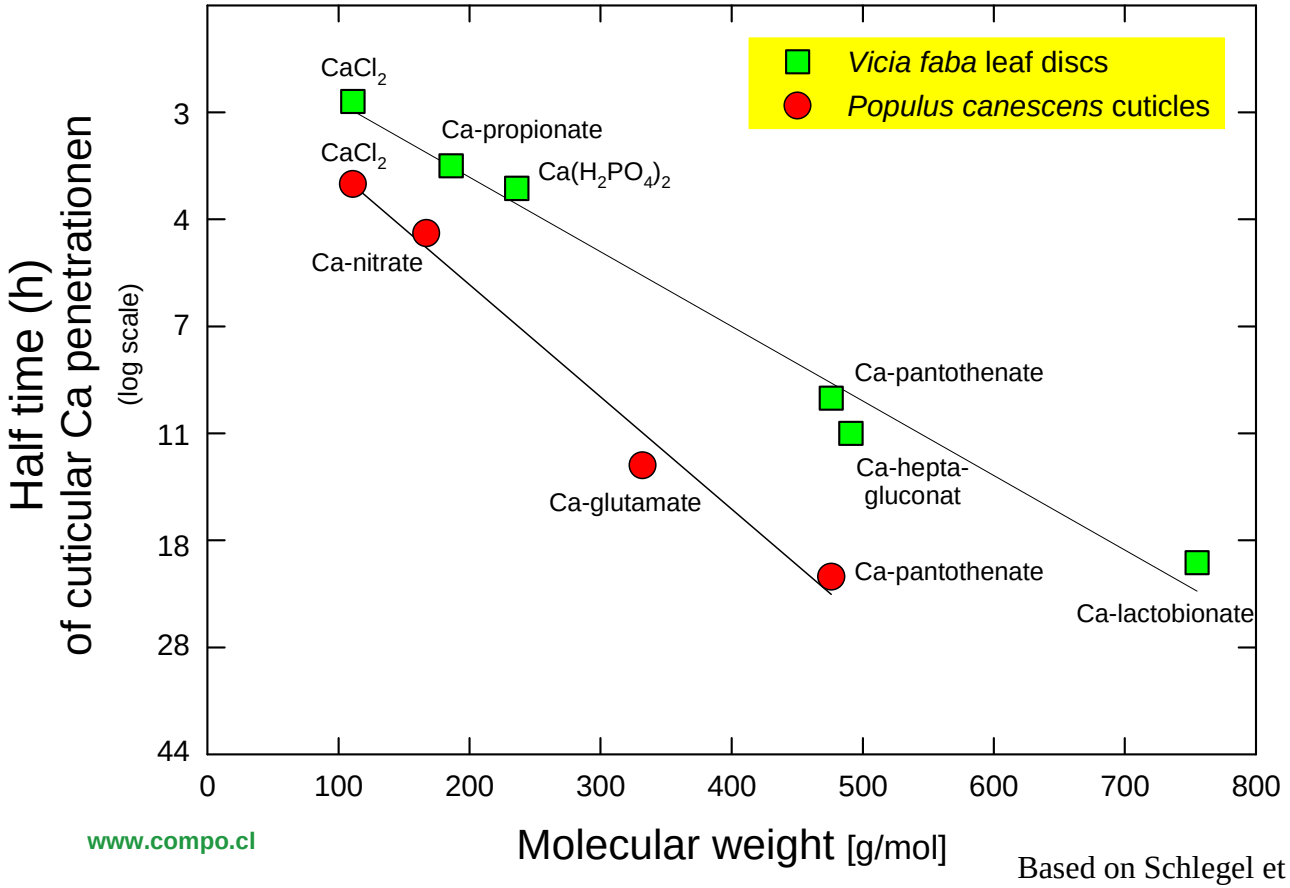




Principles of foliar fertilization

Effect of molecular weight of Ca salts on the Ca penetration across cuticles of *Vicia* and *Populus*

Model experiments at 100% humidity with stomatous leaf discs from *Vicia* and astomatous cuticular membranes of *Populus*

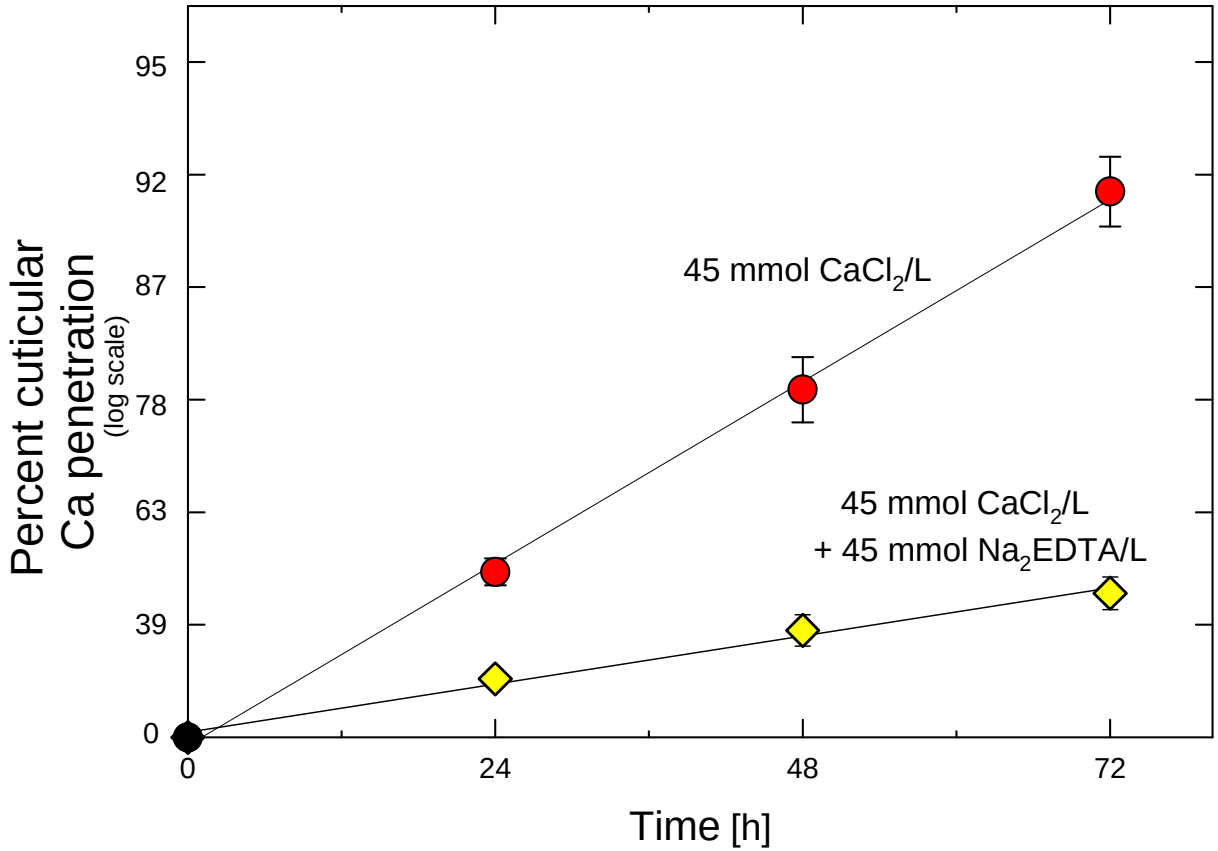


Based on Schlegel et al. (2005) Planta 221, 648-655

Principles of foliar fertilization

Effect of NaEDTA on the penetration rate of $CaCl_2$ across astomatous cuticular membrane

Model experiment with enzymatically isolated adaxial pear leaf cuticles at 90% humidity

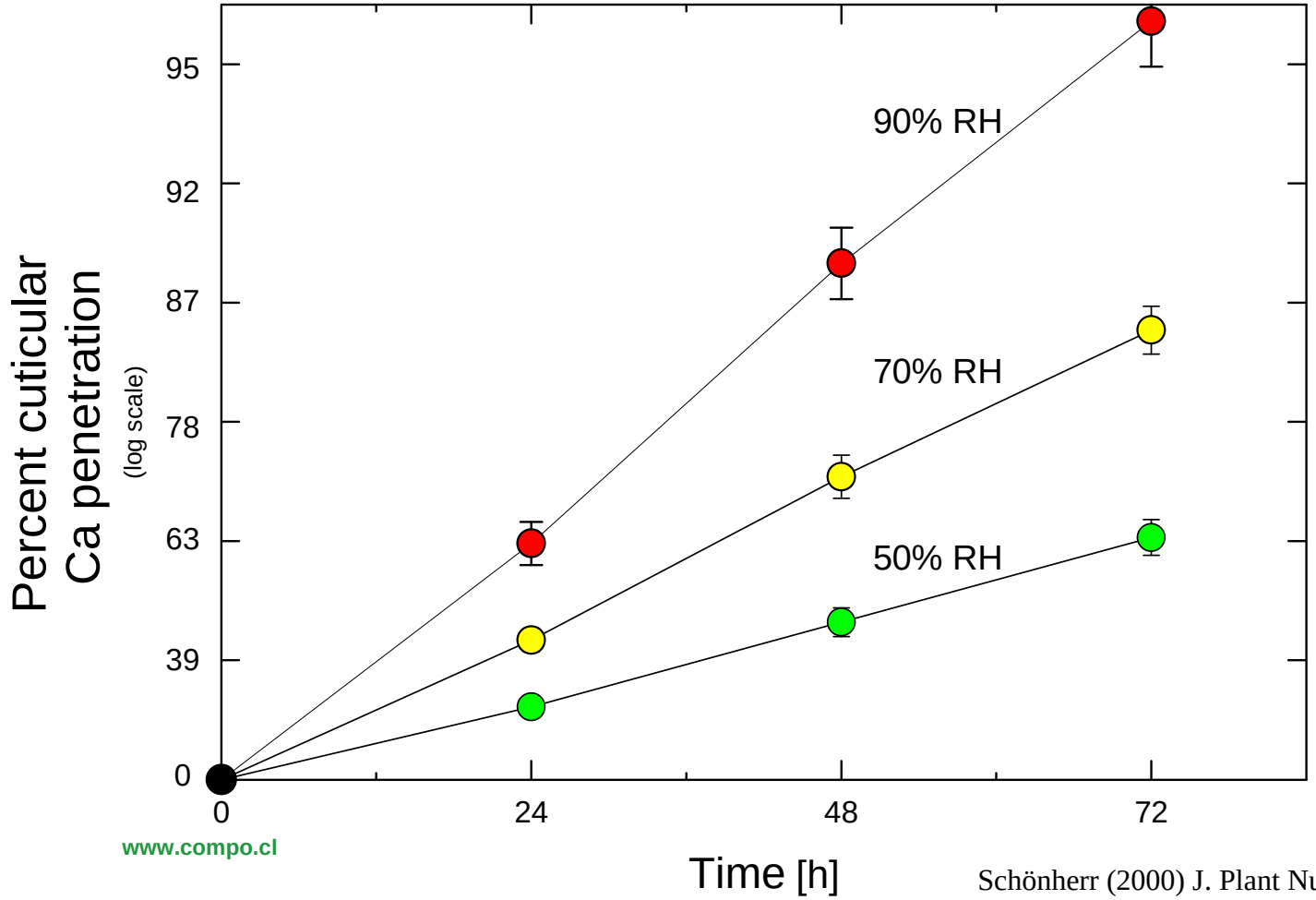


Schönherr (2000) J. Plant Nutr. Soil Sci. 174, 225-231

Principles of foliar fertilization

Effect of humidity on the penetration of Ca from $Ca(NO_3)_2$ across astomatous cuticular membranes

Model experiment with enzymatically isolated adaxial pear leaf cuticles



Schönherr (2000) J. Plant Nutr. Soil Sci. 174, 225-231

Zusammenfassung Ca

$Ca(NO_3)_2$ (oder $CaCl_2$) sind organisch komplexierten Ca-Verbindungen in ihrer Düngerwirkung als Blattdünger überlegen.

EXPERTS FOR GROWTH

Effect of Amino Acids, Auxins and Calcium on Fruit Ca Levels and Quality

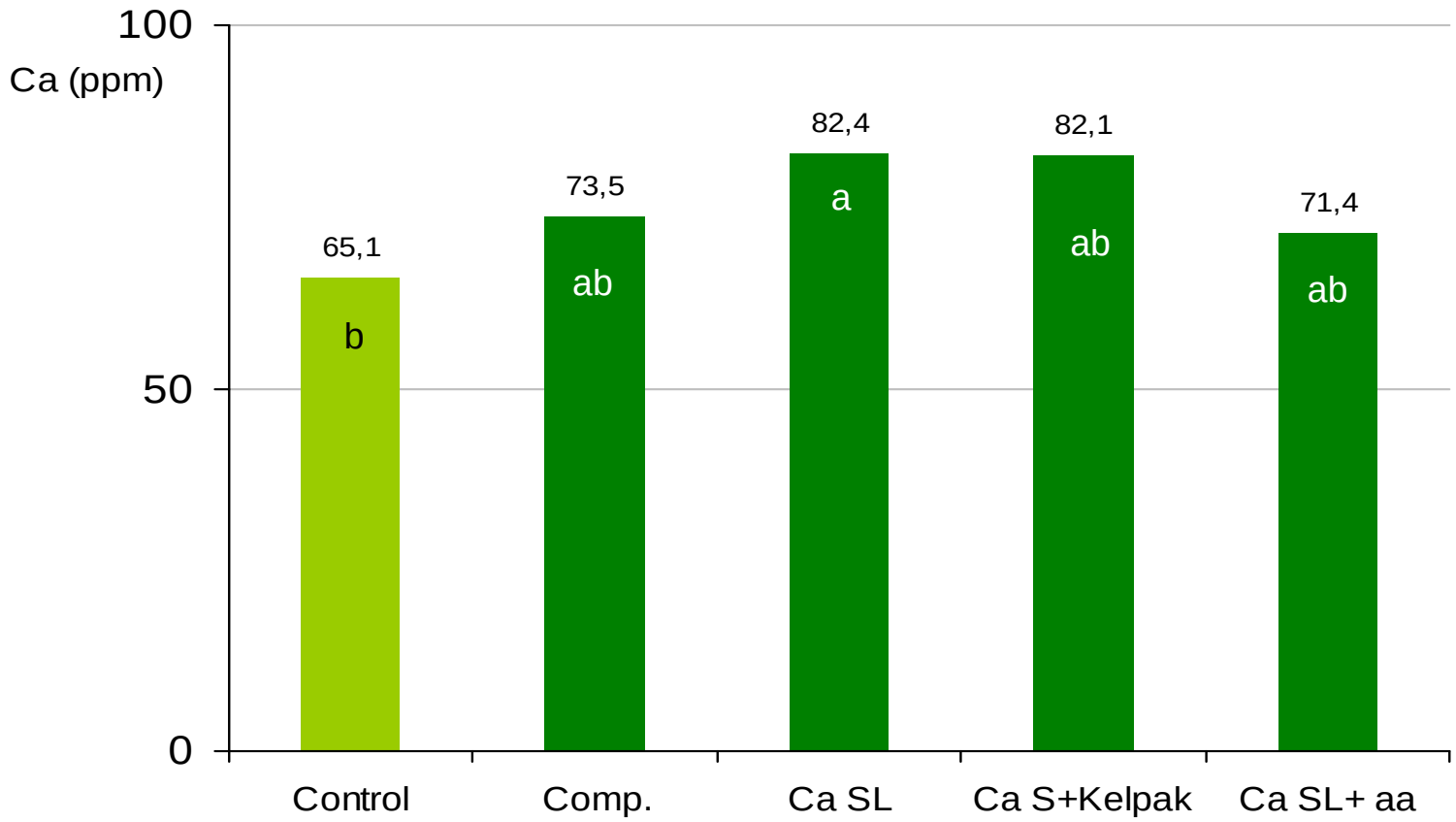
Effect of Amino Acids, Auxins and Calcium on Fruit Ca Levels and Quality in table grape cv. Thompson Seedless

Trial set - up

Treatment	Product	Rate/Application	Wetting	Time of Application (diameter of grape)			Total Rate / ha
		L - Kg/ Ha	L / Ha	4 mm	6 mm	10-12 mm	L / Kg
1	Control		2,000				
2	Competitor: $CaCl_2$ + Polypeptide	3,0	2,000	X	X	X	9
3	Basfoliar Ca Sl	2,7	2,000	X	X	X	8,1
4	Basfoliar Ca Sl + Kelp/Auxines	2,7 + 4,0	2,000	X	X	X	8,1 + 12
5	Basfoliar Ca Sl + Amino acids	2,7 + 1,8	2,000	X	X	X	8,1 + 5,4

Effect of Amino Acids, Auxins and Calcium on Fruit Ca Levels and Quality in table grape cv. Thompson Seedless

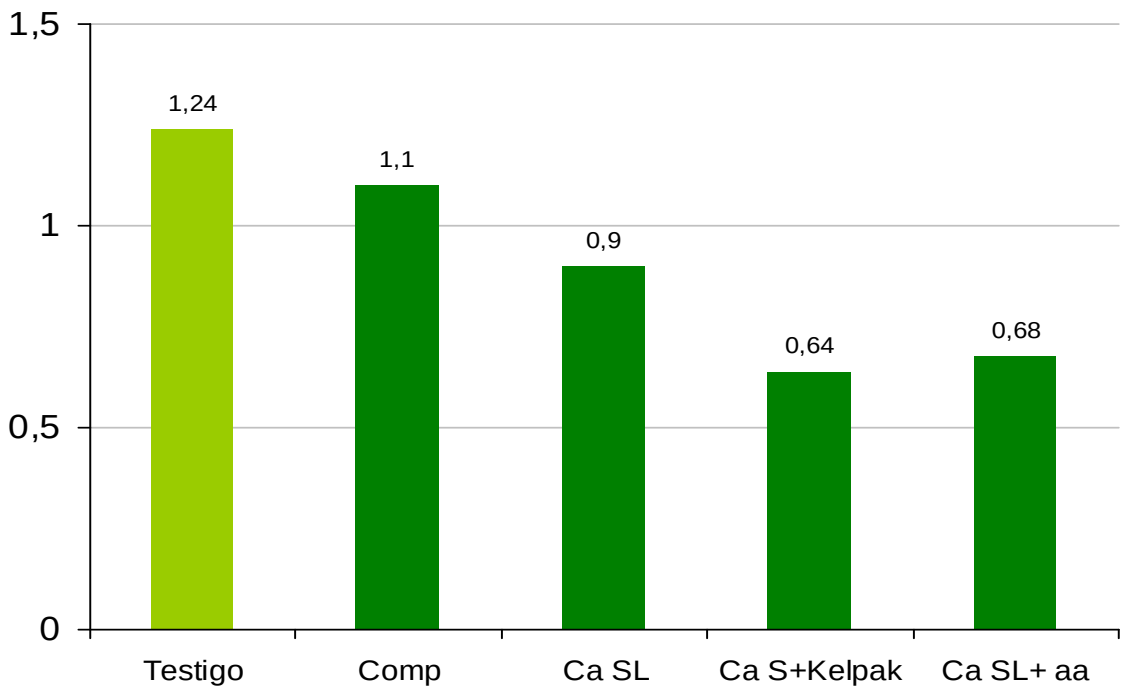
Grape Pulp Ca levels in table grape cv. Thompson Seedless.



Effect of Amino Acids, Auxins and Calcium on Fruit Ca Levels and Quality in table grape cv. Thompson Seedless

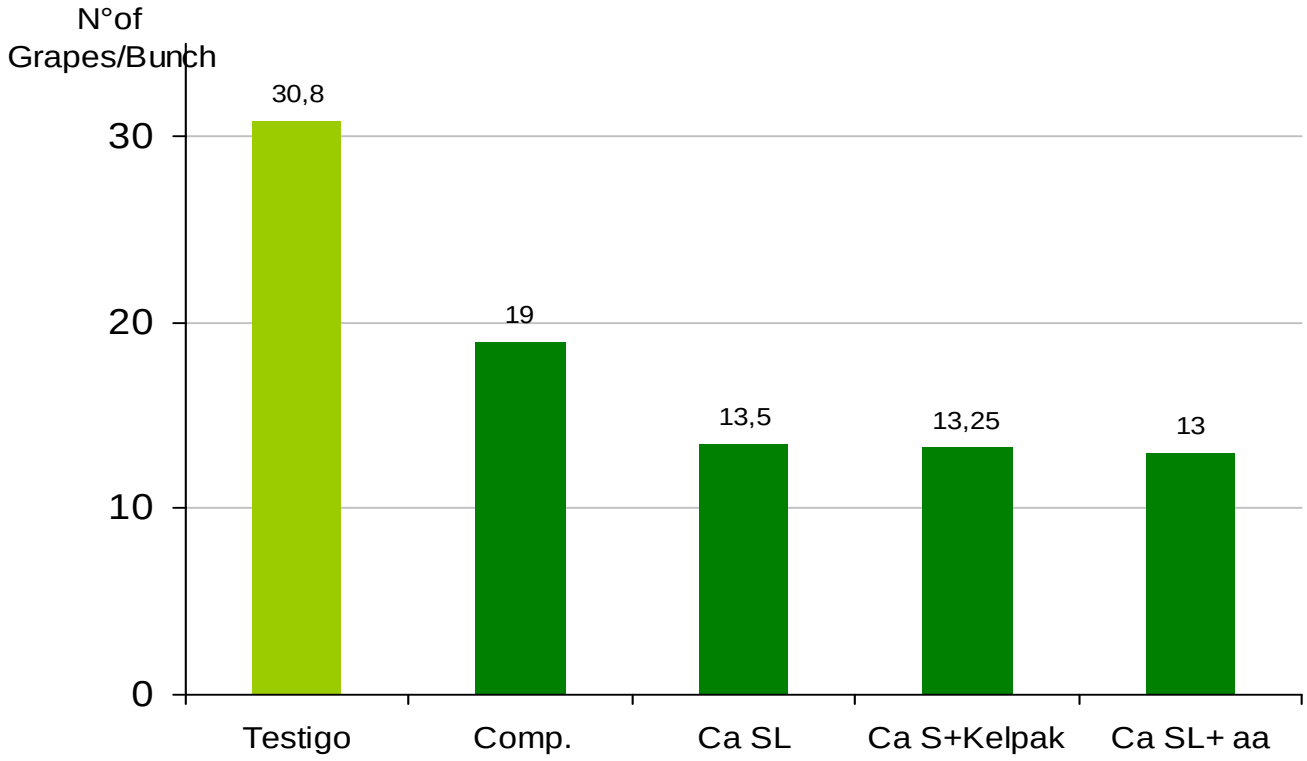
Small grapes have a tiny end on them which functions like a cap. As the grapes grow larger these caps fall off. But sometimes during a cool, wet spring a crop of grapes can fail to develop properly and this will lead to the cap at the end becoming very tough.
When the warm weather of summer arrives and as the grape matures, it will begin to push up against this cap that is now very tough. The end result being is that instead of the cap falling off the grape actually shatters against the cap due to the pressure of being pressed up against it. When this occurs it can destroy whole yields and leads to what is known as a poor fruit set with bunches that only have a few grapes.
Grape shatter is a major concern that puts many vineyards at the mercy of the weather each and every year.

Grape Shatter in table grape cv. Thompson Seedless.



Effect of Amino Acids, Auxins and Calcium on Fruit Ca Levels and Quality in table grape cv. Thompson Seedless

Grape Hair line 60 days after harvest in table grape cv. Thompson Seedless.



Conclusions

When supplied at the same rate of Calcium Basfoliar Ca SL/$CaCl_2$ showed the highest levels of Ca in the grape pulp.

Other parameters are not statistically different, but there are some tendencies to decrease the quality problems in the fruit with Basfoliar Ca Sl/$CaCl_2$.

Effect of foliar Ca and B on decrease of fruit cracking in table grape cv. Flame seedless.

Trial set-up

Treatment	Product	Rate/Application	Wetting	Time of Application (diameter of grape)			Total Rate / ha
		L - Kg/ Ha	L / Ha	4 mm	8-9 mm	10-12 mm	L / Kg
1	Basfoliar Ca Sl	6	3,000 *	X	X	X	18
2	Basfoliar Ca Sl + Solubor	6 + 1,2 Kg	3,000 *	X	X	X	18 + 3,6
3	Basfoliar Ca Sl + Solubor	6 + 1,6 Kg	3,000 *	X	X	X	12 + 4,8

*The wetting depend of the grower in this case and isn't our recommendation in table grape.
In Chile the typical wetting is 1,500 to 2,000 liters/ha.

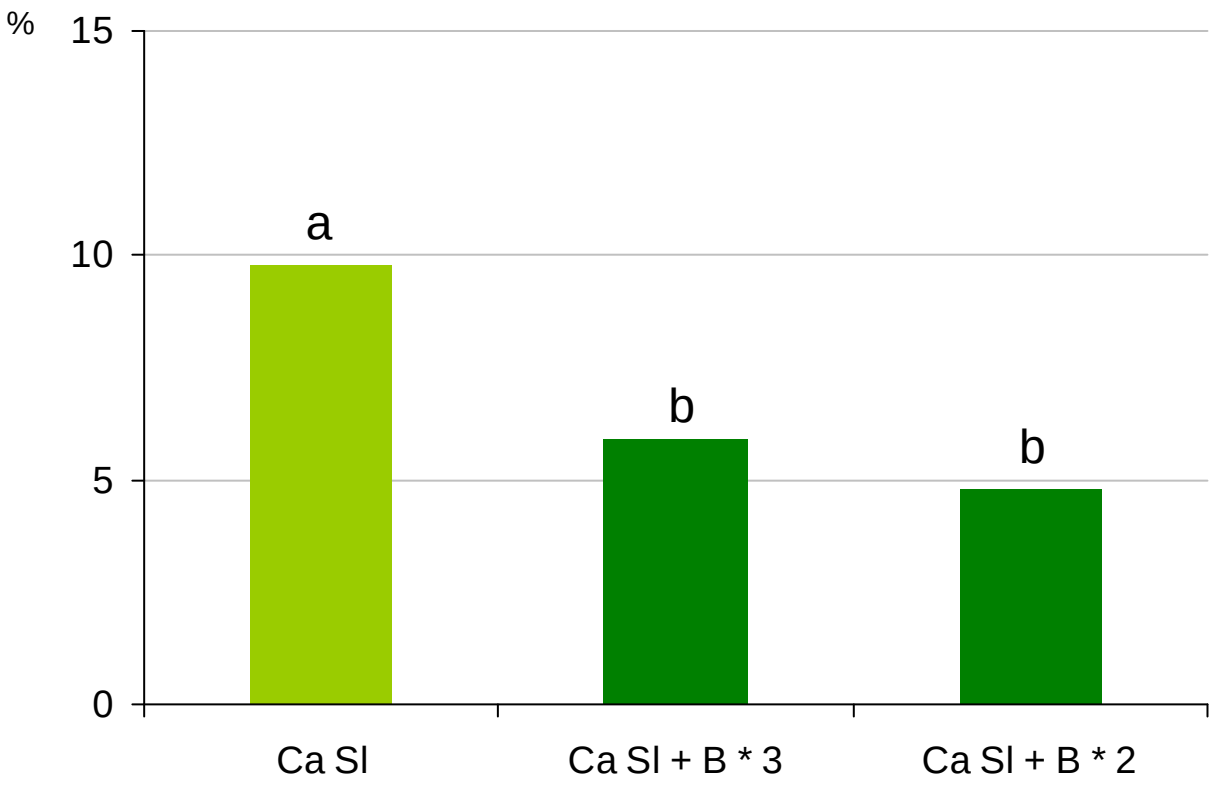
Effect of foliar Ca and B on decrease of fruit cracking in table grape cv. Flame seedless.

Effect of foliar Ca and B on decrease of fruit cracking in table grape cv. Flame seedless.

Treatment	Product	Ca (mg/100g)		B (mg/100g)		DM (%)	
		Dec 15th	Jan 22th	Dec 15th	Jan 22th	Dec 15th	Jan 22th
1	Basfoliar Ca Sl	13,4	7,8	0,21	0,53	6,7	20,3
2	Basfoliar Ca Sl + Solubor	14,5	13,2	0,41*	0,82*	8,2	22,1
3	Basfoliar Ca Sl + Solubor	15,7	11,0	0,45*	0,85*	7,2	20,1

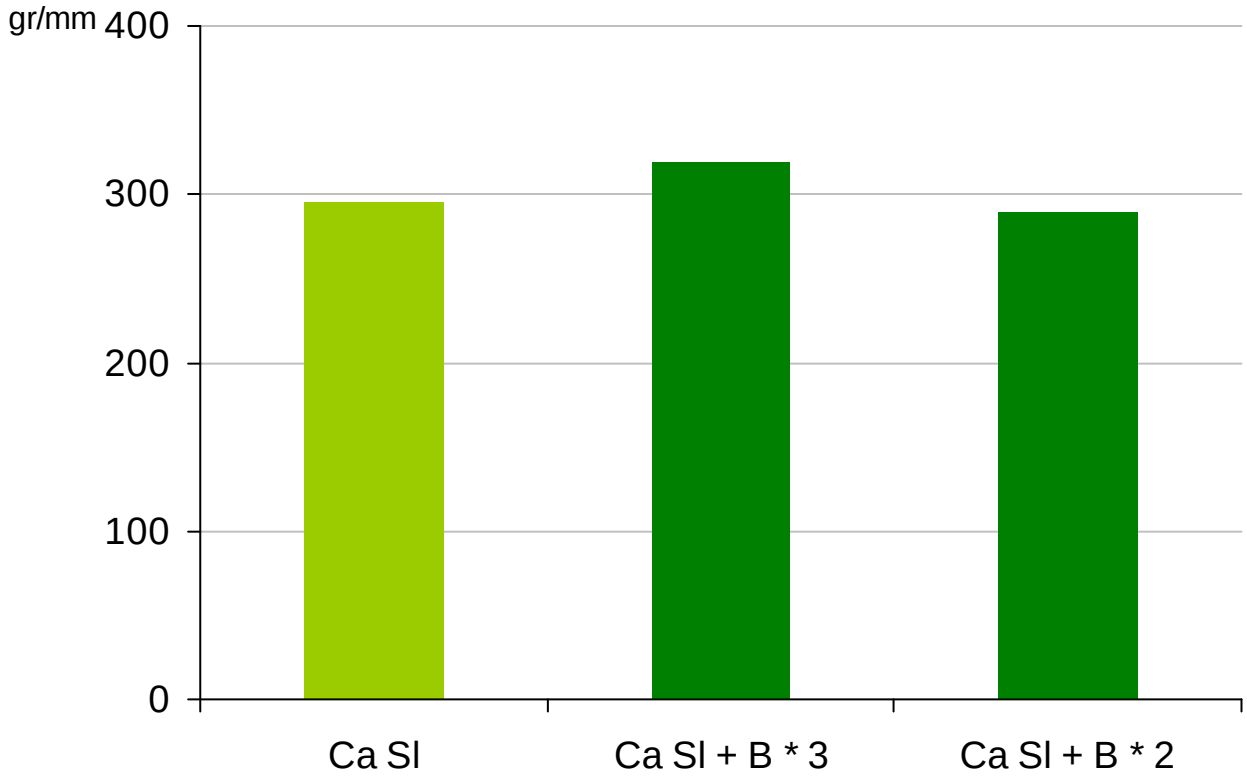
Effect of foliar Ca and B on decrease of fruit cracking in table grape cv. Flame seedless.

Effect of Ca and B on cracking severity in table grape
(% of grapes/bunch with split)



Effect of foliar Ca and B on decrease of fruit cracking in table grape cv. Flame seedless.

Effect of Ca and B on grape firmness in table grape cv. Flame Seedless.



* > 300 gr/mm = Good

Thank you for your attention
COMPO